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Hypocenter Determinations in eastern part of Southern Tien-Shan seismic zone

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Tien-Shan is located in a very complicated tectonic environment. Intracontinental mountain building ongoing here and seismic activity associated with it are mainly due to convergence of the Eurasian and Indian plates. Southern boundary of Tien-Shan is one of the most seismically active zone. In its eastern part it is a junction zone of Kok-Shaal range with stable (or nondeformed) Tarim massif. Untill recently due to relief very limited seismic stations have been operating in that area, close to China. Therefore, there were not enough reliable data to accurately locate events and the earthquake location across that boundary was always a problem. Collaborative efforts on data exchange on 3 stations and event locations with Chinese colleagues were effective before 1993. In this work we attempted to acquire P- and S- wave first arrivals from well locatable events, occured within the area under study (39º-41.6º N è 74º-80º E) for period of 1998-2000, with the aim to apply these data and hypocenter determinations for further deep structure imaging of crust by seismic tomography technique. Earthquakes at that period were recorded by permanent seismic network of Kyrgyz Republic and temporal seismic network GHENGIS, deployed at the Tien-Shan territory eastward of Talaso-Fergana fault in 1997-2000 within the frame of Project «Geodynamics of intracontinental mountain building in Tien-Shan, Central Asia», funded by NSF, USA. In addition to GHENGIS, 11 stations of KNET array and station TLG of global seismic network IRIS and station WUS of network Geoscope were used. All stations have broadband sensors: STS-2 at the stations of KNET, Geoscope, IRIS) and CMG-40T - at the stations of GHENGIS network. Permanent seismic network of Kyrgyz Republic consists of 30 seismographs with record on paper at a rate of 120 mm/min.

During experiment of 1997-2000, about 2953 earthquakes have been recorded by network GHENGIS. Picking of arrivals and catalogue compilation of Tien-Shan Bulletin were made in Broadband Seismic Data Collection Center, San Diego, USA. Picking of arrivals on records of permanent seismic network and local array KNET were maid in Experimental Methodical Seismological Expedition of Kyrgyz Republic (EMSE KR) and source parameters were catalogued also there. Earthquakes from both catalogues for solving our task were selected on following parameters: magnitude (Ì$>$3.3), epicentral distances (0-1000 km), number of recording stations ($>$8), station coverage (largest angle between neighbour stations gap$<$135°), reading error of seismic wave arrivals (0.01-0.3 s for P-arrivals and 0.3-0.5 s for S-arrivals). As result we selected 82 events.

While processing data, recorded by GHENGIS network and permanent network jointly with KNET for 1998-2000, we identified and selected 25 repeated events or doubles. Those events were independently located by different agencies based on different arrival sets. Discrepancy in epicenter locations vary from 20 km to 100 km. For each event the arrival times from both data sets were combined and events were anew located by us using the Hypoellipse [1] and three one-dimensional velocity models, obtained for Tien-Shan crust in structural studies by seismology methods (M93 [2]), P1 [3], M04 [4]). An examination of various crustal models has shown that minimum residual and error estimates are obtained for model P1. Therefore these hypocenter determinations will be used to constrain the propagation model at a regional scale. There also an attempt has been made to determine hypocenter locations and location uncertainties for 25 doubles using the model P1 and adaptively damped least squares method [5, Hypocenter code]. Location results are consistent.

Selected data set also includes 51 events recorded only by temporary network. We located these events and 277 others from both catalogue for which GAP$>$180° using the Hypoellipse and 1D model M01 and then compared hypocenter coordinates with results of relocation in 3D velocity model M01 [3] by Hypo71 algorithm, realizing multiple step-wise statistical regression [6, S.W. Roecker's code

Sphrel3D]. For data set 3D velocity model shows less average residual compare to one obtained with Hypoellipse. To asses the accuracy of hypocenter determinations reported by EMSE KR we compared obtained with Hypoellipse hypocenter parameters with those reported by EMSE KR. Comparison has shown that in case of good station coverage results are in good agreement, but if there is no station at small distance, hypocenter depth failed to be determined by Hypoellipse and Hypo71.

Results

Joint processing of events, recorded by GHENGIS network and permanent station of Kyrgyz Republic, allowed us to improve accuracy of earthquake locations in eastern part of Southern Tien Shan and to solve following critical tasks:

Catalogue of earthquakes with M>3.3 has been compiled for eastern part of Southern Tien- Shan seismic zone, one of the most seismically active;

Availability of two independently picked data set and reliable model allowed to estimate quality of initial data and get more reliable hypocenter determinations in studied area;

First arrival data set has been created based on selected 82 well and 51 fairly well locatable events and it can be used for a number of applications.

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